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COLOR-NAMES, COLOR-BLINDNESS,

AND THE

EDUCATION OF THE COLOR-SENSE

IN

OUR SCHOOLS.

BY

B. JOY JEFFRIES, A.M., M.D. (HARVARD).

REPRINTED FROM "EDUCATION," MARCH, 1882.

BOSTON:
L. PRANG AND COMPANY.
1882.

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COLOR CHART

FOR THE

PRIMARY EDUCATION OF THE COLOR-SENSE.

BY DR. HUGO MAGNUS,

Docent in Ophthalmology, in the University at Breslau,

— AND —

B. JOY JEFFRIES, A. M., M. D. (HARVARD).

THE need of proper means for teaching the elements of color in public schools has long been felt, and various attempts have been made to supply apparatus suitable for the purpose. The Color Chart designed by Dr. Hugo Magnus of Breslau, and adapted for use in American schools by Dr. B. Joy Jeffries, is believed to meet all necessary requirements.

The chart contains the following standard colors: Brown, Crimson, Red, Orange, Yellow, Green, Blue, Violet, Gray, with four shades to each color in addition. Two cards for each color are furnished for the use of pupils.

The chart is accompanied by a manual for teachers, in which its practical use in the school-room is fully explained.

COMMENDATIONS.

This chart has received the highest commendation from distinguished scientists, educators, etc., from among which the following are taken: —

From Dr. A. Von Reuss, in the Vienna Medical Press.

In urging the introduction of color-teaching in the primary schools, I am but asking what has long ago been done for the ear. Music is taught in all the schools, and I will not ask whether this is not secondary to the education of the color-sense. Moreover, for this there is no call for a new subject and study among both teacher and scholar. Color-teaching must *commence* as early as possible in the kindergarten, but more definite teaching will begin in the primary school as a part of object-teaching, and afterward associated with natural-history studies. It must of course be continued in the grammar school, and only ended with professional studies.

The suggestion of the whole subject comes from Dr. Hugo Magnus, docent of ophthalmology at Breslau, who is unwearied in urging it. He here develops, as in his former writings, a definite plan for teaching colors in the primary schools, and thus offers the necessary means of instruction. I think that this method of instruction can but commend itself to all.

From Dr. S. Kalischer, in the Gegenwart, Berlin.

Of the many methods which have lately been added to school appliances for educating the color-sense, it seems to us that of Dr. Magnus, the so well-known ophthalmic surgeon of Breslau, is by far the best. Not only has Magnus's method the advantage in the variety of the colors and their shades, but also, as it seems to us, in the fact that the children are less likely to become tired, because the activity of the hands is called into play and their attention and interest excited by the necessity of searching for two special ones among the cards. This methodical system of education cannot but help, more than anything else, the distinguishing of colors, and assist in remembering them.

Dr. Jeffries says, in his Preface to the American edition: A thorough study and trial of it induced me to abandon all other ideas, and endeavor to introduce it into our schools. After I had made this decision, I was much gratified to find that the plan had met with the especial approval of the highest authority, Dr. Magnus having received the following diploma from the International Medical Congress at the Amsterdam meeting in 1879: —

CONGRÈS INTERNATIONAL DES SCIENCES MÉDICALES.

6e Session.

AMSTERDAM, 1879.

Diplôme d'admission avec mention honorable (distinction unique décernée par le Comité) délivré à M. le Docteur HUGO MAGNUS, à Breslau.

Le President, DONDERS.

Le Secrétaire Général,
DR. GUYE; DR. W. C. GORI.

La Direction de l'Exposition,
TILANUS, VAN LISSA.

It is with Dr. Magnus's especial consent and approval that the chart is published here in America.

Price of Chart, Cards, and Manual - - - - - - $5.00.

L. PRANG & COMPANY, Publishers.

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COLOR-NAMES, COLOR-BLINDNESS, AND THE EDUCATION OF THE COLOR-SENSE IN OUR SCHOOLS.

BY B. JOY JEFFRIES, A.M., M.D., HARVARD.

It is not always remembered that the eye has, so to speak, two senses; viz., form and color. The sense of form and the defects of the eye interfering with it have been very thoroughly studied the last five and twenty years, and some knowledge of the same diffused in the community, who now recognize the words myopia, hypermetropia, or astigmatism, etc. Teachers and educators have naturally heard a great deal more about myopia and its being caused by school-life, the dangers arising from it, and its prevention.

The sense of color has only been quite recently studied in such a way as to bring an acquaintance with it within the scope of the general community. For the sense of form the eye, as a *camera obscura*, has to be very perfect, and quite complicated in its power of adjustment. For the sense of color a very simple eye will suffice. None of the accommodative apparatus of the organ need be present. The media need not be transparent, as is required in form-perception. The crystalline lens may be opaque,—namely, cataract,—and yet the eye be able to appreciate color quite well, when its form-perception is reduced to light and shade.

For both form and color-perception the eye is most perfect in the center, from here outwards becoming more and more defective. Look carefully with one eye at a word as long as "constitution" on an ordinary printed page, and it will be seen that in reality only the first three or four letters are distinct. The muscles of the eyeball turn it so easily along the line that we hardly notice that it is only the centre of the retina which perceives accurately. Now the same is true of the sense of color, which is also best at the yellow spot, as it is called, in the centre of the retina. Look steadily forward with one eye while the other is shut, and at the same time move a small bright-colored object, as a red wafer, gradually from the centre of the field outwards. One will be surprised to find how soon it loses its color and appears, finally, black, whilst its outline can still be dimly perceived. There is a central zone in which we see the three primary colors,—red, green, and violet; around this another, in which only two, green and violet, are seen; and outside of this, the rest of the retina perceives only violet or blue. This, at least, holds true under ordinary illumination.

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After gazing at an object for but a short time its picture remains upon our retina, turn our eyes away as we will. This is the so-called after-image. On awakening in the morning, when the retina from rest is more sensitive, and looking steadily at some picture with a dark frame, then turning the eyes away, we shall see it wherever we direct our gaze; but the frame will appear of the reverse, namely, white. Now this is also true as to color. If we gaze at a green disk across the room, and have it suddenly removed, a red or pink one will appear in its place. The after-image, as it is called, will always assume the complementary color. These facts, amongst many others relative to the normal color-sense, are often unrecognized or forgotten. Their bearing on colored signals, by night or day, is, of course, a very practical one.

All over the civilized world communities are being awakened to the curious facts connected with the defect called color-blindness. These facts, hitherto regarded as of simply scientific interest, have assumed a practical value, which forces them to be recognized even by those who would officially ignore or suppress them because they come counter to their own ignorance, prejudice, or pecuniary interests, etc.

Investigation of a railroad accident in Sweden, supposed to be due to color-blindness, led Dr. F. Holmgren, professor of physiology in the University of Upsala, to the belief that the defect must be frequent, and hence dangerous on both land and sea. Difficulty arose as to any certain method of detecting it quickly. The absence of any such method has been the especial reason why the defect has hitherto escaped observation. Using the theory of Young-Helmholtz, and applying a test suggested by Seebeck, he finally brought out his now well-known method with the colored worsteds. By this, and the imitations of it devised here and there, large numbers of persons have been examined all over the world, including both sexes, all colors, ages, and degrees of civilizations, etc. It is a curious fact, that till the expert could test quickly and accurately, the existence of color-blindness to the extent now proved remained unknown. It is now admitted that four per cent. of males are more or less color-blind, and in females not over one-fourth of one per cent. are thus affected. My own tests, up to the time of writing this, are of 19,101 males 801 were color-blind, whilst I found but 11 females among 14,731 defective in their chromatic sense.

Color-blindness may be said to exist as red, green, or violet blindness; the first two including each other, and the last involving blindness to the complementary color; viz., yellow. Violet-blindness is so rare that the term color-blindness means, now-a-days, red or green blindness. It will be noticed how these colors correspond to the sensation derived through the three retinal zones before described, etc. Whilst the mistakes as to colors a color-blind makes are very characteristic, and seem most extraordinary, yet when we come to define what the defect is, it will be found not so easy or simple. Perhaps the best conception, and one most readily retained and kept in mind, is this ; viz., that to the color-blind (red or green-blind) all colors containing either of their two defective ones become so much darker, and seem as if they had been made with gray, or black and white mixed. This, of course, is in proportion to the amount of the color-blindness and the amount of the red or green in the given color.

Color-blindness has not been detected by present methods of teaching colors by charts, colored objects, etc. It has escaped detection even where the best methods were employed by very intelligent teachers. This, however, is not so strange when we realize how it is not discovered in every-day life, and that even the adult and educated color-blind are found ignorant of their defect, often stoutly resenting any lack of chromatic visual power.

Recent extended research has proved some facts in relation to color-blindness which must be taken into consideration in relation to teaching colors in the schools. It is a congenital defect, and, as has been said, much more frequent in the male than in the female. It is hereditary, and follows the general law of heredity. Females, though they escape it, transmit it to their male offspring. As there is no rule without an exception, so here also the defect has been found in all the females of several generations of one family, and only in them, the males, normal-eyed. It may occur congenitally in *one eye only*. Several monocular cases have been seen and carefully examined by very competent observers. Age, color, race, civilization, or occupation do not seem to have any influence on its frequency to judge by present statistics.

The color-blind who can be put into the so-called hypnotic or mesmeric condition have temporarily been able to see colors normally ; also the normal-eyed who can be put into this condition are rendered, for the time they are so, like the color-blind as to chromatic sense. Injuries which affect the brain may cause what is practically color-blindness, and in one eye only. Such cases are recorded. It has long been known as a symptom of certain cerebral affections, or cerebral and ocular troubles described in ophthalmic treatises.

A condition of chromatic defect simulating perfectly color-blindness is produced by chronic poisoning from alcohol and from tobacco, or both combined, — not but what thousands of people abuse both these stimulants without having their chromatic sense interfered with. It is meant only that when they produce serious trouble, often most insidiously: then the person is dangerous as a signaler on land or sea, for his power of seeing colors may be below the normal. The *in*temperate lecturers, who have recently quoted the writer as having explained the greater amount of color-blindness among males by their greater abuse of alcohol and tobacco, have, of course, made the story out of whole cloth. It is, however, too strong an untruth for them not to continue to do so, notwithstanding any remonstrance.

Congenital color-blindness is incurable, but may be somewhat palliated. It has been long known that in artificial light (not the electric) the color-blind did not make such gross mistakes, and more readily concealed their defect. Now, looking through a piece of lemon-colored glass, equivalent to gas-light, will help the color-blind in daylight or in electric light. The same is true of looking through a solution of gelatin stained with the aniline red dye, called fuchsine. There is no temporary or permanent change of the color-sense from all this, but simply alterations of light and shade which the color-blind have learned, unconsciously, to avail themselves of. This very interesting point, as also how they learn to escape detection, cannot be here dwelt on: it would need an article longer than this.

Congenital color-blindness is *incurable*. No amount of practice with colors, or familiarity, will alter the color-sense. This is now so well understood and recognized that it would be but a waste of time to argue about it. The idea arose, first, from some observers supposing that children were color-blind because they did not know the color-names of objects, and that this was cured when they had learned and could remember these; secondly, from the color-blind themselves and their surroundings, imagining that the defect was altered or remedied because it was, even unconsciously, more easily concealed. The bearing and force of all that has so far been said will be apparent when we sum up the facts; viz., that color-blindness exists in four per cent. of males, that it is incurable, and that it most readily escapes detection, no methods of teaching colors exposing it. There are four boys out of a hundred who can never be made, by any means we know of, to see colors as the other ninety-six readily do.

The only way we have of knowing how a sensation affects another person is by what they say or what they do. Now, as to the effect of color on the brain, we cannot trust the tongue in color-names. The color-blind *may* use the same names as the normal-eyed, hence we must cause them to exhibit their mental impression by muscular effort. This we can readily do in methods of testing dependent on the principle of *comparison.* Of the comparison-method, Holmgren's, with colored-worsteds, is by far the simplest, and can be made use of in the primary schools without introducing anything new. A *correct selection* of worsteds is only required, and these can be employed in the object-teaching now introduced almost everywhere. A full description of the method will be found in my manual, "Color-blindness, its Dangers and its Detection." This should be a reference-book in the schools, accompanying a standard set of worsteds. If, on the study of the description of the test and the application of the latter, the principal or teacher fails to decide the presence or absence of chromatic defect in a scholar, then an expert can be consulted, and must be; because not only should the principal or teacher not waste time over a color-blind child, but the parents or guardian ought to know of the defect. It is most important that there should be the earliest knowledge and recognition of color-blindness, since it must affect the child's future career and choice of occupation, etc. I found color-blind children of railroad engineers in our Boston schools whose one idea was to follow their father's employment. In a Savannah school I found two brothers color-blind whose father was a Savannah pilot. Fortunately the present United States laws would prevent these boys taking up their father's profession. But not only where there is *danger* from color-blindness should warning be given as to the child's future. In all employments where a recognition of color is important the color blind are debarred, as experience amply proves. It is cruel to let them unconsciously take up occupations in which their defect will surely cause them to fail, sooner or later.

This examination of the color-sense which has gone on in the last few years in various parts of the civilized world, has developed a hitherto unrecognized fact; namely, the extraordinary ignorance, on the part of males, of colors and color-names: this not only with school-boys of all social grades, but even among quite well educated adults. During the first six months of my work testing in our Boston schools I could not believe my eyes or my ears, and the teachers were as astonished and with difficulty persuaded of the truth. The same experience has since been reported by all examiners in Europe. Girls learn colors and color-names from occupations and home-life, dress, etc. In a general way it has been presumed that boys did the same, till the reverse has gradually dawned upon us, resulting from continued absolute experiment.

The lack of a knowledge of colors and color-names is, however, quite a serious drawback in very many occupations, especially among our manufacturing and artistic industries, etc. Why do not males discriminate colors and shades as females do? Simply because they are not taught them systematically, and they have no opportunities of learning them out of school. The higher the social grade of boys, the more they will be found to know of colors and color-names from home-surroundings. It may be, however, quite as important that the lad who is to seek his living as an artisan, should be instructed in colors and color-names. The necessary teaching can be carried out with no further time devoted to it than is now wasted in what is considered instruction.

The last quarter of a century has shown how the ear, the voice, and the hand can be trained and educated. In the sense of form the eye has been wonderfully taught. The sense of color has been almost totally neglected. That it can be equally taught and educated there is abundant proof of in the extraordinary delicacy of the sense attained by so many workmen in colored fabrics, etc., mosaic setters, and the like. It is not here meant that methodical and careful education will develop the sense in the individual beyond its natural power, but that such teaching will enable the eye to discriminate *within its range*, as does the ear within its range, etc. On the other hand, it is equally not *denied* that generations of teaching *may* heighten the color-sense and render it more acute. It has lately been proved that the sense of sight and hearing exists to a greater degree in uncivilized men, where these qualities are required to obtain food by the hunt, or escape danger from enemies, animals, or men.

It is very evident that teaching color in the schools must embrace the detection of color-blindness in the boys, the learning the names of the commonest colors at least, the sharpening the appreciation and discrimination of colors, and thus the gradual education of the color-sense. To do this, instruction must commence in primary or Kindergarten work, and be steadily pursued through school-life.

Colors must be taught, and not simply the color-names of colored objects. A blind child will give the name of the color of grass, trees, apples, bananas, bricks, its companion's clothes, and perhaps even hundreds of objects the color-name of which it has learned. So also the color-blind boy will do the same. It is one thing to learn the color-name connected with a remembered *object*, and a very different thing to connect the right name with the sensation a green color arouses. Here has been the mistake which object-teaching has rather fostered than corrected.

Any method must be systematic and thorough, commencing at the very bottom. How little was accomplished in educating the ear, the voice, and the sense of form for the eye, till correct principles were understood and acted on. Nothing can be accomplished in color teaching till the mistakes of the past are understood, admitted, and corrected. The very means adopted have but helped to blind the teacher and the educator in the belief that colors were being taught, when, in reality, nothing but names associated with certain objects were being remembered. The color-blind boy can, as I have seen, point out the colors in the charts heretofore used, as well as the normal-eyed. A certain spot in a certain position on a large card has a name attached to it which he remembers, and this is all he has learned. It is very true that many a teacher, disgusted with the charts, blocks, etc., placed in her hands, has discarded them all, and gathered together larger or smaller collections of colored paper, worsted, ribbons, etc.; but no exercise with these has revealed the characteristic mistakes of the color-blind boys she has taught. I have detected color-blindness among the best-taught classes. I have witnessed the best color-teaching, and there was really nothing in it which would inevitably detect a defect of the color-sense. It would not have astonished me at all to have found, on trial, one of the exhibited boys color-blind. I found in a factory a color-blind man engaged in cutting up colored board into cards. His fellow-workmen would not, of course, admit his defect, but his employer had experienced a "destruction of stock," and could appreciate the characteristic mistakes he showed with Holmgren's test, etc. It is not expected that this idea of the need of connecting a name with a sensation will be received at once, as it seems so to militate against every-day knowledge. It will, however, gradually show itself in the systematic color-teaching, which is here argued for. Practical illustrations in our schools would much more readily prove this statement.

When early in my work of testing the many thousands I have, I recognized the ignorance of color-names and lack of appreciation of colors, etc., I endeavored to work out some method of teaching which should be of avail. I became convinced that any method, to be successful and meet the necessary requirements above formulated, must be based on the principle of comparison, by which alone we get hold of the effect of color on the brain itself. I saw at once why all the means hitherto adopted and officially accepted had failed, and I readily understood why intelligent teachers had dropped them as useless, and why they were always so interested in what I had to show and say about systematic methods based on the true principle of comparison.

I worked out mentally certain plans of instruction, and found how others had done the same. I could contrive none which satisfied me as meeting the wants which my experience in the schools called for. When I finally received from Dr. Magnus of Breslau his color-chart and method of teaching, which was awarded an honorary diploma at the International Medical Congress at Amsterdam, in 1879, I decided that he had best solved the problem. He had reached the solution through exactly the same training I had passed through; viz., continued work in testing and studying the color-sense in the schools. It has much interested me to see how this method has been spoken of by the gentlemen in Europe who were best competent to judge; viz., those who had found out from personal experience in examining the defects existing and the special needs in any color-teaching. All examiners who have written about their work agree as to the ignorance of colors and color-nomenclature, and the existence of color-blindness in the boys, not suspected heretofore, and not detected by any of the methods employed in color-teaching.

The continued attempts in Europe, only partially successful, to print colored plates to test for color-blindness have shown the great technical difficulties with all color work. Fortunately such insurmountable difficulties do not exist in reference to Dr. Magnus's chart. Still these have been such as to prevent Mr. Prang from preparing the chart up to this time. This he will soon do. With it will be an explanatory pamphlet which I have adapted to the needs and peculiar condition of our primary teachers in this country. The fundamental idea of the method is to first teach children colors, — that is, render their eye familiar with them,—and after this, the names of the colors. Thus we shall avoid their simply connecting a color-name with an object, as can a blind boy or a color-blind boy. This method of using the principle of comparison has been carefully worked over by several teachers and educators, who have kindly given me their opinions, suggestions, and criticisms, especially in reference to my explanatory pamphlet. All these fortified me in the deductions I had made from my own personal experience in many thousand tests of people of all ages and all classes.

In the use of this chart of Magnus's a color-blind boy will, sooner or later, make such characteristic mistakes as to call the teacher's attention to him, especially as these mistakes are described in the explanatory pamphlet. Thus the chart, being based on the principle of comparison, will serve the purpose of teaching colors and color-names, and the *probable* detection of color-blindness. Such teaching will be a new era, and the first commencement of systematic color-teaching. Upon it, as experience unfolds the needs and necessities, can be built up in the future the whole fabric of advanced color-teaching, and that will in the future educate the color-sense within its present power of education. Whether generations of color-teaching will finally alter the chromatic sense in males, and thereby reduce the proportion of color-blindness in that sex, it is certainly at present useless to affirm or deny. It is with no such idea that this chart is introduced into this country; and it is not brought forward with the idea of detecting color-blindness by it: it is only claimed that it is a very simple and practical method, based on the true principle of comparison, which, in practical use, will most probably, as no methods ever have, warn the teacher of a child's chromatic defect when present. With it, in every school where it is used, should be a type-set of Holmgren's worsteds and the manual adopted by the U. S. Government for medical officers of the army, navy, and marine-hospital service as to pilots. My manual I recommend because there is no other in English, and it will be invaluable to the primary or grammar teacher, or superintendent, as a book of reference. In most of the primary schools of the large cities of this country are already collections of worsteds, ribbons, paper, etc., costing much more than a type set of correct worsteds, now readily obtainable.*

This type set of worsteds will serve for the object-teaching as now conducted. A set lasted me for ten thousand examinations in the schools. All the worsteds now on hand, as also the ribbons, paper,

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*TESTING FOR COLOR-BLINDNESS. — The method of examination adopted is the one fully described in this manual, namely, Professor Holmgren's, with certain colored worsteds. This is also the test used by medical experts in detecting color-blindness amongst *railroad employés*, and the one used in the schools, and in the recent investigations of the color-sense of uncivilized tribes in various parts of the world, a mutual language not being necessary for examiner and examined.

The value of the test depends upon its being carried out strictly in accordance with Professor Holmgren's directions, given in this manual. For this purpose it is absolutely necessary to have the *correct colors and shades of worsteds*, which are not easily procured, therefore, —

At the Meeting of the American Ophthalmological Society at Newport, July 25, 1879, *it was resolved,*

"That Dr. B. Joy Jeffries be requested to make such arrangements as he may find practicable to enable the members of the Society and others to procure suitable collections of colored worsteds for testing color-blindness."

In compliance with this request the following arrangement has been made with the undersigned: They agree, on the receipt of $2.50, to send by mail, postpaid, to any address, a complete and accurate set of worsteds, including the *tests*. On the receipt of $4.50 they agree to send, postpaid, to any address, a set of the worsteds *and* the manual of Dr. Jeffries above referred to.

N. D. WHITNEY & Co.,
129 *Tremont street.* Boston, Mass., U. S. A.

silks, etc., can be equally well used as before; but a full type set of worsteds are sufficient for all object-teaching purposes.

In 1869, I criticised "optics and the eye," as taught at the universities.* I consulted with the professors teaching these branches, and went over the subject in the various text-books on physics. I showed the apparent utter ignorance of authors and translators as to the modern researches of such distinguished physiologists, also well-known in general science, as Helmholtz and Donders. My criticism had some effect, as I found that the Harvard students were allowed to omit the many pages of antiquated theory in "Lardner's Optics." Moreover, the late Professor Snell, at Amherst, was at the time preparing another edition of "Olmstead's College Philosophy." Desiring to have it correct and up to time in respect to the eye and optics, he came to Boston, and we went over the whole subject together. The result was his incorporating the researches of the above-mentioned physiologists, and introducing reproductions of the diagrams, etc., I used in my lectures on Optical Phenomena at Cambridge. This is not the place to discuss whether the text-books are *now* correct on the well-known points concerning the organ of vision: I merely speak of the matter to show how, year after year, the same mistakes are repeated in and taught from the text-books, till some one takes the trouble to point them out, and is persistent enough to overcome publishers *stereotyped* pecuniary considerations.

Dr. Magnus's color-chart, which I propose introducing as the simplest and most practical method for commencing primary color-teaching, is not based on any *theory* of color or color-perception. There must, however, naturally follow it color-manuals for the upper classes precisely as there has in reference to form-perception in drawing. Just what such further and higher instruction may be, and how carried out, will depend on this primary work and how far it can bring the scholar. A true foundation of color-instruction must be built up first, on which can be erected a thorough scientific and practical education in chromatics.

The first step, however, in further instruction leads us to the necessity of speaking of, deciding on, and teaching the primary colors. To help break the way for the true primaries, which science can alone admit,—viz., red, green, and violet,—I would here call attention to the fact that, still in text-books, color-charts, and even educational reports, the primaries are spoken of as red, yellow, and blue; as if Helmholtz had not, thirty years ago, showed Brewster's mistakes in experimenting. Scientific men may even think me ridiculous in introducing so settled a question here. Teachers and educators, however, realize that it is time some step was taken to clear up the textbooks, and stop, at least, false instruction.

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* Boston Medical and Surgical Journal, Aug. 5, 1863; pp. i.–iv.

I have met, where I least expected it, such total ignorance of the fact that red, green, and violet *were* the real primaries,—so proved by science,—that, whilst to defend myself seems almost puerile, yet I must refer doubters to some standard works within their reach.

Professor Ogden M. Rood says, in his "Modern Chromatics," p. 109: "This theory of the existence of three fundamental kinds of light,—red, yellow, and blue,—is found in all except the most recent text-books in physics, and is almost universally believed by artists. Nevertheless, it will not be difficult to show that it is quite without foundation."

In von Bezold's "Theory of Color," translated by Mr. Kœhler, and published in 1876 by Mr. Prang, is, on page 128, the following: "Red, yellow, and blue were generally looked upon in former times as the fundamental colors, the results obtained by the mixture of pigments having been accepted as a basis. Later investigations lead to the conclusion that green must be substituted for yellow, and a variety of reasons might be cited, all of which speak unanimously in favor of assuming *red, green,* and *blue,* which borders closely on *violet,* to be the fundamental colors."

Another book within the reach of all teachers is Alfred M. Meyer and Charles Barnard's little manual on "Light," where the true primaries are explained. Too many of our Boston teachers have had opportunity, within the past few years, to hear Professor Cross of the Institute of Technology, in his Lowell Lectures and the Art Society Lectures, *prove* to them experimentally the true primaries, to be willing to accept and attempt to teach from any text-book red, yellow, and blue as primary colors. A reading-book was recently rejected by the Boston School Supervisors because two chapters about colors taught the old fundamental errors. Our text-books and readers must be made scientifically correct, to open a true path for the future further teaching of colors and the education of the color-sense.

COLOR-BLINDNESS:

ITS DANGERS AND ITS DETECTION (*Revised and Enlarged Edition*). By B. Joy Jeffries, A. M., M. D. (Harvard), Fellow of the Massachusetts Medical Society; Ophthalmic Surgeon Massachusetts Eye and Ear Infirmary, Carney Hospital, and N. E. Hospital for Women and Children, etc. 1 vol 8vo. $2.00. Published by Houghton, Mifflin & Co., Boston.

This important work has been heartily welcomed by medical and scientific journals in America and Europe. It has been adopted as a standard manual for medical officers of the United States Army, Navy, and Marine Hospital service. A careful perusal of the following notices will show in what esteem it is held by competent judges in both hemispheres:—

"In this present treatise Dr. Jeffries gives us 'a good part of Prof. Holmgren's book,' and he contributes, on his own part, the result of over eighteen thousand testings for color-blindness, made by himself according to Prof. Holmgren's method, with colored worsteds, among New England teachers and scholars. Both works are, first and foremost, 'practical,' having in view the elimination of color-blind persons from the railway and marine services." — *The Nation, New York.*

"We have to thank Dr. Joy Jeffries for his very intelligently written and useful little volume, which fills a hiatus that has been much felt. In this he has not only collected the principal facts that have been given by his predecessors, but he has added the results of his own observations and labors. We have great pleasure in recommending Dr. Jeffries's book to all who are engaged in the examination of the color-blind." — *The Lancet, London.*

"To Dr. B. Joy Jeffries is due the credit of bringing this matter to the attention of the United States in a way which cannot fail to produce good results. In a busy professional life he has still found time for a thorough study of all that has been printed on the subject, for correspondence with the scientific men abroad who have investigated it, for translations from many languages, and for making here thirty-four thousand examinations for color-blindness." — *Boston Daily Advertiser.*

"Dr. Joy Jeffries of Boston, who has himself contributed to the general stock of knowledge of this subject, has done English-speaking people everywhere a service in presenting the results of those labors, and especially of Prof. Holmgren of Upsala, in the present exhaustive manual." — *The Scotsman, Edinburgh.*

"This book is written throughout from a practical point of view. The author is chiefly occupied with a consideration of the practical effects of color-blindness and the dangers caused by it." — *Journal of the Society of Arts.*

"The author's aim is essentially practical. He seeks to point out the dangers to life and property which may arise from the employment on railways or on shipboard of men defective in the color-sense, and to explain in detail the best means for their detection. These dangers are undoubtedly real and serious. To the medical profession it will prove an indispensable guide in the examination of supposed cases of color-blindness." — *Journal of Science.*

"There is no doubt of the existence of this dangerous defect of vision amongst railway employés, and no time should be lost in taking steps to institute a thorough examination of railway employés throughout the kingdom. The volume now under review deals very fully with the whole question, and very clearly explains the method to be adopted in examining for color-blindness." — *The Railway News and Joint Stock Journal, London.*

"This is an interesting contribution to this important subject. The author has been successful by his unremitting zeal and perseverance in arousing public attention in America to the danger of employing color-blind railway officials." — *The British Medical Journal*

"It is opportune that we are able to announce the appearance of a work which, although not by an Englishman, is in our language, and will therefore make the English-reading public acquainted with what has been done. The author is ophthalmic surgeon to several hospitals. He is otherwise much connected with ophthalmological matters, and has had large experience in regard to color-blindness." —*Nature, London.*

"A volume has been published by B. Joy Jeffries, M. D., of Boston, entitled 'Color-Blindness: Its Dangers and Detection,' which is an exhaustive popular statement of all that is at present known on the subject, and is fully up to the standard we have indicated." — *Harper's Magazine.*

"The author is himself an eminent ophthalmic surgeon, and has contributed important original investigations to the general stock of knowledge upon the subject, so that what he has now written may be said to possess the sanction of a double authority,—that of Prof. Holmgren in addition to his own." — *London Times.*

"Any one who engages in the study will find himself anticipated in every direction by Dr. Jeffries, who has pursued it with unwearied industry, and to whom the community is deeply indebted for his labors." — *Massachusetts Railroad Commissioners' Report*, 1880.

⁂ *This work is sold by booksellers, or it will be sent, postpaid, on receipt of the price, by the Publishers.*

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THE THEORY OF COLOR

IN ITS RELATION TO ART AND ART INDUSTRY,

BY DR. WILHELM VON BEZOLD,

PROFESSOR OF PHYSICS AT THE ROYAL POLYTECHNIC SCHOOL OF MUNICH, AND MEMBER OF THE ROYAL BAVARIAN ACADEMY OF SCIENCES.

Translated from the German by S. R. KOEHLER.

With an Introduction by

EDWARD C. PICKERING, *Thayer Professor of Physics at the Massachusetts Institute of Technology.*

Authorized American Edition, Revised and Enlarged by the Author. Illustrated by Chromo-lithographic Plates and Woodcuts. One vol. Large 12mo. $5.00.

PUBLISHERS' NOTE.

PROF. VON BEZOLD'S "Theory of Color" commends itself to the public for the following reasons: Most of the numerous books on the subject, even some of those lately written, totally ignore the progress made in physiological objects within the last thirty years. In these works the untenable theories of Brewster and of Field are still accepted as a basis; but, the basis being faulty, it follows of necessity that the superstructure must likewise be faulty. On the other hand, the few works which have attempted to popularize the results of the researches of Maxwell and Helmholtz have either failed to carry out to their logical consequences the views at present held, or else have proved to be abortive on account of the abstruse manner in which their authors presented the difficult subject. The theories of Brewster and of Field above alluded to are more especially those relating to the so-called three primary colors, red, yellow, and blue. Modern science has shown that white light is not resolvable into these three primaries. The theory of the three primary colors, red, yellow, and blue, has therefore been abandoned, and with them the whole system of so-called secondary and tertiary colors has fallen to the ground. It might be feared that anarchy would take the place of order in the realm of color after the overthrow of the old system of classification. This is not the case, however, for the system of colors adopted by Prof. von Bezold not only affords a ready means of classifying every sensation of color which may possibly affect the eye, but even is exceedingly simple.

The first three chapters of the book are devoted to the exposition of the physical and physiological basis of the theory of color, according to the most recent scientific developments, to the manner in which colors are perceived, to the law of mixtures (one of the most curious and interesting divisions of the science), and to the system of colors.

The numerous illustrations, colored as well as black (5 full-page chromo-lithographic plates, 6 full-page plates on colored paper, and 65 wood-cuts), are an exceedingly valuable feature of the book, while the unusually full index will make it a most convenient book of reference. Although the book is primarily intended for artists and art students, scientific men will nevertheless also find much valuable and interesting matter in it, as the manner of treatment chosen by the author necessitated a thorough and perfectly independent manipulation of all the scientific material bearing on the subject. Such a manipulation, even if it should not bring to light new facts, must very naturally present many an old fact from a novel point of view.

Prof. von Bezold is sufficiently well known among the scientific men of Europe. The fact that he is introduced to the American public by PROF. EDWARD C. PICKERING, of the Massachusetts Institute of Technology, and by so good a translator as MR. S. R. KOEHLER, will no doubt secure to him a favorable reception on this side of the water.

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